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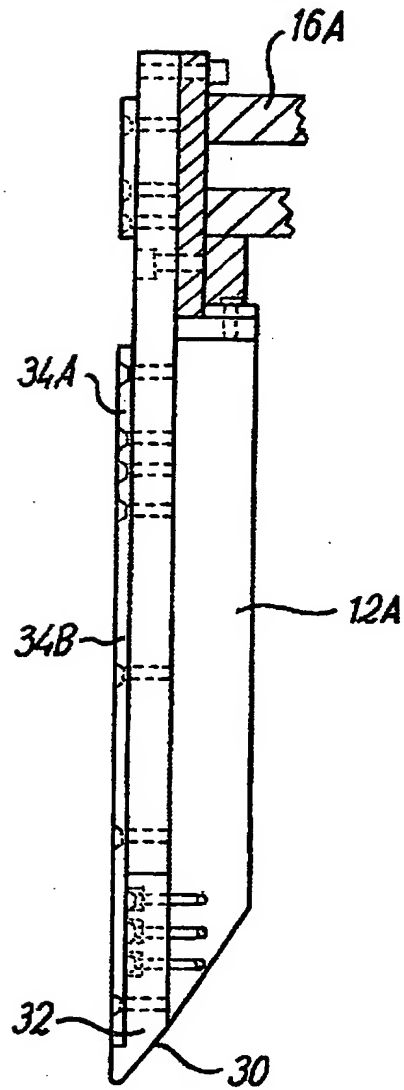


FIG. 4

Pile Driving

The present invention relates to pile driving and in particular, to apparatus for applying piling forces to pile elements.

Piles may be driven as a single item or in sections, according to the operating conditions, pile length required and the like. For simplicity, the term "pile" will be used herein to refer both to a unitary pile and to a section of a sectional pile, i.e. to a single element being driven, whether to form a pile alone, or one section of a longer pile.

In many applications, piles are required to be strong, rigid and inflexible, and may be made of metal, wood, concrete or other rigid material. In other applications, such as for shoring trenches, other types of pile are used, such as relatively thin sheets of plastics material, or thin metal sheet. These piles are flexible and consequently difficult to drive. As piling forces are applied to the top of the pile, the pile is likely to buckle unpredictably and depending on the resistance presented by the ground. Conventional piling actuators are attached to the top of a pile which must therefore support the weight of the actuator, thereby giving rise to an increased risk of buckling.

In order to avoid problems with buckling, it has been proposed to use short piles and small, light actuators producing relatively low piling forces. This results in low penetration rates and depths and may make flexible piles unusable in hard ground.

The present invention provides a pile driving arrangement comprising jaws which grip a pile, in use, to allow piling forces to be applied to a pile through the jaws, the jaws being elongate to extend alongside the pile to provide support against the pile flexing under the influence of piling forces.

The face of at least one of the jaws preferably has a gripping region having a surface formed to assist in gripping a pile. Preferably both jaws have a

gripping region. The or each gripping region is preferably rendered gripping by a surface coating. The or each gripping region may be coated with a particulate coating, such as a diamond grit coating.

The face of at least one of the jaws preferably has a relatively gripless or smooth region to assist in removal of the arrangement from the ground alongside a pile after the pile has been driven. Preferably both jaws have a relatively gripless region. The or each relatively gripless region may be formed by polishing, and may be provided by a polished metal surface.

Preferably at least one jaw has a gripping region and a relatively gripless region. The gripping region is preferably above, in use, the relatively gripless region. Preferably both jaws have a gripping region and a relatively gripless region.

Preferably the leading end of at least one jaw is toughened against wear. Preferably at least the leading end of at least one jaw is pointed in shape, to improve ground penetration.

The arrangement preferably comprises a clamping mechanism operable to move the jaws relative to each other to grip or release a pile. Preferably the clamping mechanism is arranged to allow a pile to be gripped from one side. The arrangement may comprise a detachable connection means operable to connect the arrangement with a piling actuator.

The jaws may be at least 750 mm in length, and preferably 800 mm or more.

The invention also provides a method of driving a pile, in which the pile is gripped by means of jaws which extend alongside the pile to provide support against the pile flexing under the influence of piling forces, and piling forces are applied to the pile through the jaws.

Preferably the jaws are arranged to grip the pile from one side. Preferably the jaws remain gripping the pile as the pile and jaws are driven into the ground. Preferably the jaws are opened after penetrating the ground, to be withdrawn from the ground, and are then re-applied to grip the pile at a higher position for further driving.

The method may be effected by means of a pile driving arrangement as set out in any of the preceding definitions.

In a second aspect, the invention provides a pile driving arrangement comprising jaws which grip a pile, in use, to allow piling forces to be applied to a pile through the jaws, the jaws having an upper gripping region and a lower relatively gripless region whereby to facilitate removal from the ground after the jaws have penetrated the ground during pile driving.

The pile driving arrangement of the second aspect of the invention may have any feature or combination of features as set out above in connection with the first aspect of the invention.

Examples of the present invention will now be described in more detail, by way of example only, and with reference to the accompanying drawings, in which:-

Fig. 1 is a perspective view of a pile driving arrangement according to the present invention;

Fig. 2 is a plan view of the arrangement of Fig. 1, with the piling actuator removed;

Fig. 3 is a vertical section to the arrangement of Fig. 2, viewed at the line 3-3 in Fig. 2; and

Figs. 4 and 5 are elevations of the jaws at the line 4-4 in Fig. 2, with other

components shown sectioned.

The drawings show a pile driving arrangement 10 which has jaws 12 which grip a pile 14 to allow piling forces to be applied to the pile 14 through the jaws 12. The jaws 12 are elongate, to extend alongside the pile 14 to provide support against the pile flexing under the influence of piling forces.

In more detail, the jaws 12 are each attached at their upper end to a respective arm 16 of a clamp arrangement 18. One jaw 12a is attached to a fixed arm 16a to which a pivot arm 16b is pivoted at 20. Both arms 16 extend beyond the pivot 20 for attachment to an actuator cylinder 22 by which the arms 16 may be opened and closed to bring the jaws 12 together, or move them apart. In this example, the jaw 12b is attached to the pivot arm 16b by a further pivot at 24, to allow some re-orientation as the jaws 12 move. This may not always be required and could be omitted. Alternatively, both arms 16 could carry jaws 12 by means of pivot connections.

The fixed arm 16a carries a coupling 26 by which the arrangement 10 can be coupled to a piling actuator 28, shown schematically in Fig. 1. It is envisaged that the arrangement 10 can be used with an actuator 28 of the vibratory or hammer type. In the latter case, the coupling 26 will incorporate an anvil against which the actuator 28 may strike.

It will thus be apparent that during use, a pile 14 may be gripped between the jaws 12 to allow piling forces to be applied to the pile, through the arrangement 10, from the actuator 28. During piling, the jaws 12 will extend alongside the pile, as shown in Fig. 1. The jaws 12 therefore support the pile against flexing under the influence of piling forces, the weight of the actuator 28, or the like. In consequence, a heavier actuator can be used, and larger piling forces can be used, without the pile 14 flexing or breaking.

It is envisaged that a jaw length of at least 750 mm, and preferably 800 mm, will provide adequate support for a wide range of flexible piles, when used

as described below. Flexible piles are typically in excess of 2m in length.

The construction of the jaws 12 is shown in more detail in Figs. 4 and 5.

The fixed jaw 12a (Fig. 4) is attached to the arm 16a at its upper end, by appropriate bolts, or other connections. The jaw 12a extends down from the arm 16a to its lowermost extremity, where the jaw 12a is formed into a point at 30. The tip 30 may carry a wear plate 32 of toughened material. The provision of a pointed tip 30 and wear plate 32 improves ground penetration during driving.

The inner face of the jaw 12a, opposing the jaw 12b, carries upper and lower face plates 34a, 34b. Both are removably attached to the jaw 12a to allow for replacement in the case of wear. The upper face plate 34a is formed to enhance the grip achieved between the jaw 12a and a pile. For instance, the face plate 34a may be roughened or otherwise textured, but preferably carries a surface coating, such as an industrial diamond grit coating, or other particulate coating, to provide a hard, high grip surface able to achieve good purchase on a pile 14. This ensures good transmission of piling forces from the arrangement 10 to the pile 14.

By contrast, the plate 34b is designed to minimise grip between the plate 34b and the pile 14. The plate 34b is preferably smooth, such as polished metal. This distinction is significant when withdrawing the arrangement 10, as will be described below.

The pivot jaw 12b is attached to the pivot arm 16b by the pivot 24, and is otherwise substantially similar to the fixed jaw 12a, in extending down to a tip 30 formed by a wear plate 32, and carrying an upper face plate 34a of gripping surface type, and a lower face plate 34b of smooth surface.

The significance of the face plates 34a, 34b can now be described in more detail, by reference to the arrangement in use. Initially, a pile 14 will be above

ground, and can be gripped from one side between the jaws 12 by operation of the cylinder 22. The pile will be gripped at a position at or close to the ground. Piling can then commence by operation of the actuator 28 to apply piling forces to the arrangement 10 and thus to the pile 14 by virtue of the grip provided by the plates 34a. As driving continues, the plates 34b will support the pile 14 against buckling between the ground and the plates 34a. The jaws 12 will penetrate the ground and thus increase the resistance presented by the ground against piling, but it is envisaged that the provision of the pointed tips 30 can reduce this additional resistance to an acceptable degree.

As piling continues, a position will be reached at which the jaws 12 must be removed from the ground in order for piling to continue. This is achieved by first opening the jaws 12 to release the pile 14, by operation of the cylinder 22. Resistance from the ground is likely to give rise to some distortion in the jaws 12 as they are opened, allowing them to open more widely toward the upper end (at or near to the ground surface) than at the lower ends, which will be embedded. Consequently, it is likely in practice to be easier to open the jaws 12 sufficiently widely to clear the plates 34a from engagement with the pile 14, than it would be to wholly separate the plates 34b from the pile 14. However, the smooth surface of the plates 34b will not engage the pile 14 in any manner to significantly restrict withdrawal of the jaws 12, once the grip of the plates 34a has been released. The plates 34b can slide up past the pile 14, without any risk of pulling the pile 14. The jaws can then be used again, to grip the pile at a higher position (or to grip a further section of pile), and driving can then continue as described above, until the pile is driven as deeply as is required.

It will be apparent from the above description that many variations and modifications can be made to the apparatus described above, without departing from the scope of the present invention. In particular, many different shapes, sizes and materials can be chosen, according to the intended application, the nature of the pile to be driven, and the like.

Whilst endeavouring in the foregoing specification to draw attention to

those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

CLAIMS

1. A pile driving arrangement comprising jaws which grip a pile, in use, to allow piling forces to be applied to a pile through the jaws, the jaws being elongate to extend alongside the pile to provide support against the pile flexing under the influence of piling forces.
2. A pile driving arrangement according to claim 1, wherein the face of at least one of the jaws has a gripping region having a surface formed to assist in gripping a pile.
3. A pile driving arrangement according to claim 2, wherein both jaws have a gripping region.
4. A pile driving arrangement according to claim 2 or claim 3, wherein the or each gripping region is rendered gripping by a surface coating.
5. A pile driving arrangement according to claim 4, wherein the or each gripping region is coated with a particulate coating.
6. A pile driving arrangement according to claim 5, wherein the particulate coating is a diamond grit coating.
7. A pile driving arrangement according to any of the preceding claims, wherein the face of at least one of the jaws has a relatively gripless or smooth region to assist in removal of the arrangement from the ground alongside a pile after the pile has been driven.
8. A pile driving arrangement according to claim 7, wherein both jaws have a relatively gripless region.
9. A pile driving arrangement according to claim 7 or claim 8, wherein the or each relatively gripless region is formed by polishing.

10. A pile driving arrangement according to claim 9, wherein the or each relatively gripless region is provided by a polished metal surface.
11. A pile driving arrangement according to any of claims 7 to 10, wherein at least one jaw has a gripping region and a relatively gripless region.
12. A pile driving arrangement according to claim 11, wherein the gripping region is above, in use, the relatively gripless region.
13. A pile driving arrangement according to claim 11 or claim 12, wherein both jaws have a gripping region and a relatively gripless region.
14. A pile driving arrangement according to any of the preceding claims, wherein the leading end of at least one jaw is toughened against wear.
15. A pile driving arrangement according to any of the preceding claims, wherein at least the leading end of at least one jaw is pointed in shape, to improve ground penetration.
16. A pile driving arrangement according to any of the preceding claims, wherein the arrangement comprises a clamping mechanism operable to move the jaws relative to each other to grip or release a pile.
17. A pile driving arrangement according to claim 16, wherein the clamping mechanism is arranged to allow a pile to be gripped from one side.
18. A pile driving arrangement according to any of the preceding claims, wherein the arrangement comprises a detachable connection means operable to connect the arrangement with a piling actuator.
19. A pile driving arrangement according to any of the preceding claims, wherein the jaws are at least 750 mm in length.

20. A pile driving arrangement according to claim 19, wherein the jaws are 800 mm in length, or more.
21. A pile driving arrangement substantially as described above, with reference to the accompanying drawings.
22. A method of driving a pile, in which the pile is gripped by means of jaws which extend alongside the pile to provide support against the pile flexing under the influence of piling forces, and piling forces are applied to the pile through the jaws.
23. A method of driving a pile according to claim 22, wherein the jaws are arranged to grip the pile from one side.
24. A method of driving a pile according to claim 23, wherein the jaws remain gripping the pile as the pile and jaws are driven into the ground.
25. A method of driving a pile according to claim 24, wherein the jaws are opened after penetrating the ground, to be withdrawn from the ground, and are then re-applied to grip the pile at a higher position for further driving.
26. A method of driving a pile according to any of claims 22 to 25, wherein the method is effected by means of a pile driving arrangement as set out in any of claims 1 to 21.
27. A method of driving a pile, substantially as described above, with reference to the accompanying drawings.
28. A pile driving arrangement comprising jaws which grip a pile, in use, to allow piling forces to be applied to a pile through the jaws, the jaws having an upper gripping region and a lower relatively grippless region whereby to facilitate removal from the ground after the jaws have penetrated the ground during pile driving.

29. A pile driving arrangement according to claim 28 and further comprising any feature or combination of features as set out in any of claims 1 to 21.

30. Any novel subject matter or combination including novel subject matter disclosed herein, whether or not within the scope of or relating to the same invention as any of the preceding claims.



INVESTOR IN PEOPLE

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Claims searched: 1-27, 29

Examiner: Dr. Lyndon Ellis
Date of search: 2 May 2001

Patents Act 1977 Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK Cl (Ed.S): E1H HGH
Int Cl (Ed.7): E02D
Other: Online: EPODOC, WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X, E	GB 2347452 A (Horsfall) Whole document	1, 16-20, 22-24, 26

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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